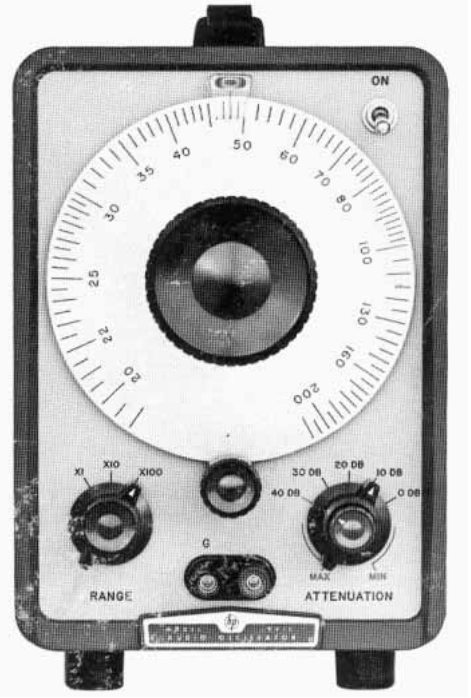
HP

OPERATING AND SERVICE MANUAL

AUDIO OSCILLATOR

201C



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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

-hp- Part No. 201C-906

MODEL 201C
AUDIO OSCILLATOR

Serials Prefixed: 0961A

Appendix C, Manual Backdating Changes, adapts this manual to Serials Prefixed: 351-06357 and below, 331-, 311-, 308-, 236-, 133-, 006- and serials 1358 to 557 and below.

P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

Printed: Aug 1971

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Frequency Range: 20 Hz to 20 kHz in three ranges.

Ranges	
X1	20 Hz to 200 Hz
X10	200 Hz to 2 kHz
X100	2 kHz to 20 kHz

Calibration Accuracy: ±1%. Calibration controls provided for standardizing bands.

Frequency Stability: ±2% under normal temperature conditions and including initial warmup, aging of components etc.

Dial: 6-inch diameter, calibrated over 300° of arc. Total scale length 50 inches.

Frequency Response: ±1 dB over entire frequency range. (Reference 1 kHz.)

Output: 3 watts maximum or 42.5 volts into 600-ohm load. One terminal at ground potential. 50 volts maximum no-load voltage.

Distortion: Less than 1/2%, 50 Hz to 20 kHz at 1 watt output. Less than 1%, 20 Hz to 20 kHz at 3 watts output.

Attenuator: 0 to 40 dB in 10 dB steps–concentric amplitude control varies output continuously zero to maximum at any attenuator setting.

Output Impedance:
600 ohms ±10%, 20 dB, 30 dB and 40 dB settings.
Less than 600 ohms, 0 dB and 10 dB settings.

Hum Voltage: Less than 0.03% of rated or attenuated output. (Amplitude control at maximum.)

Power: 115/230 volts ± 10 %, 48/440 Hz 85 W nominal. 120 W maximum.

Accessories Available:

HP 11000A Cable Assembly, 4 feet of RG-58/U 50-ohm coaxial cable terminated at each end with a dual banana plug.

HP 11001A Cable Assembly, 45 inches of RG-58/U 50-ohm coaxial cable terminated at one end with a dual banana plug and with a UG-88/U Type BNC male connector at the other.

Dimensions:

Cabinet Mount: 7-1/2 inches wide, 11-1/2 inches high, 12-1/2 inches deep. (191 X 292 X 318 mm).

Rack Mount: 19 inches wide, 6-31/32 inches high, 10-5/16 inches deep (482,6 X 177,0 X 261,9 mm).

Weight:

Cabinet Mount: Net, 16 lbs. (7,2 kg); Shipping, 19 lbs. (8,6 kg).

Rack Mount:
Net, 20 lbs. (9 kg); Shipping, 30 lbs. (13.5 kg).

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Model 201C Audio Oscillator (Figure 1-1), has been designed for a general purpose, audio testing and measurements such as amplifier testing, transmission line measurements, loud-speaker testing, frequency comparison, and other high fidelity tests. It contains a built-in stabilized amplifier stage delivering 3 watts of power into a 600-ohm resistive load with distortion held to 1/2 per cent at frequencies above 50 Hz at 1 watt output and less than 1 per cent from 20 Hz to 20 kHz at 3 watts output.

1-3. The output level of the Model 201C is adjustable. An attenuator is also provided to adjust the output level over a 0 to 40 dB range in 10 dB steps. The attenuator is a bridged-T type providing virtually a 600-ohm impedance looking back into the instrument (at attenuation levels of 20 dB and above), and keeps the hum level low relative to small signal levels. With the attenuator in the 0 dB position, output impedance becomes less than 600 ohms, thus insuring good voltage regulation for varying load conditions providing maximum output power.

1-4. INSTRUMENT IDENTIFICATION.

1-5. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument within the series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured.

1-6. If the serial prefix of your instrument differs from the one on the title page of this manual, a change sheet will be supplied to make this manual compatable with newer instruments or the backdating information in Appendix C will adapt this manual to earlier instruments. All correspondence with Hewlett-Packard should include the complete serial number.

1-7. ACCESSORIES AVAILABLE.

1-8. 11000A Cable Assembly. This cable assembly consists of two dual banana plugs and a section of RG-58C/U 50-ohm coaxial cable, 44 inches overall. Plugs are for binding posts spaced 3/4 inch between centers.

1-9. 11001A Cable Assembly. This cable assembly consists of a dual banana plug, a UG-88/U Type BNC male connector and a section of RG-58C/U 50-ohm coaxial cable, 45 inches overall. The dual banana plug is for binding posts spaced 3/4 inch between centers.

Figure 1-1. Model 201C

SECTION II
INSTALLATION

2-1. INSPECTION.

2-2. Unpack the instrument upon receipt and inspect it for signs of physical damage such as scratched panel surfaces, broken knobs, etc. If there is any apparent damage, file a claim with the carrier and refer to the warranty page in this manual.

2-3. An electrical inspection should be performed as soon as possible after receipt. To aid in electrical inspection a list of performance checks are in Section V, Paragraph 5-8. These procedures make a good test as part of incoming quality-control inspection.

2-4. POWER REQUIREMENTS.

2-5. The Model 201C requires a power source of 115/230 volts ± 10 %, 48 to 440 Hz, which can deliver up to 120 watts.

2-6. POWER CABLE.

2-7. For the protection of operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-prong conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground pin.

2-8. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the pigtail on the adapter to ground.

2-9. 230-VOLT OPERATION.

2-10. To operate the Model 201C from a 230-volt ±10% source, change the primary windings of T2 from a parallel to a series arrangement. Refer to the schematic diagram and proceed as follows:

a. Remove the two bare wire jumpers from the terminals on T2. These jumpers connect terminal 2 to 3 and 4 to 5 on the primary winding.

b. Connect a new jumper between terminal 3 and 4.

c. Change the line fuse to a 0.8 A slo-blo.

2-11. REPACKAGING FOR SHIPMENT.

2-12. The following is a general guide for repackaging for shipment. If you have any question, contact your local -hp- Sales and Service Office. (See Appendix at the back of this manual for office location.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

a. Place instrument in original container if available. If original container is not available, a suitable one can be purchased from your nearest -hp- Sales and Service Office.

If original container is not used,

b. Wrap instrument in heavy paper or plastic before placing in an inner container.

c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.

d. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

e. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE" etc.

SECTION III
OPERATING INSTRUCTIONS

3-1. CONTROLS AND TERMINALS.

3-2. ON. Toggle switch controls line voltage to instrument.

3-3. RANGE. Three-position rotary switch selects various values of resistance in the bridge circuit of the RC oscillator. The position of this switch indicates the multiplying factor for the frequency dial calibration.

3-4. FREQUENCY dial. This control varies the capacitance in the bridge circuit of the RC oscillator to vary output frequency between range switch steps. The dial is calibrated from 20 to 200 and its indication multiplied by the factor indicated by the RANGE switch will give the actual output frequency of the oscillator. The small knob below the frequency dial is a vernier control for the dial.

3-5. ATTENUATION. This is a dual concentric control. The inner control is a potentiometer which adjusts the amplitude of the oscillator voltage admitted to the amplifier, and therefore, it adjusts the output voltage of the instrument from zero to a maximum value established by the attenuator. The outer control is a bridged-T type attenuator providing 0 to 40 dB of attenuation in 10 dB steps.

3-6. OUTPUT terminal. Two binding posts on the lower center of the front panel are the output terminals for the oscillator. Terminal marked G is connected to the chassis of the instrument.

3-7. OPERATING INSTRUCTIONS.

a. Connect the power cable to required power source.

b. Turn the power switch ON and allow approximately five minutes for the instrument to reach its normal operating temperature.

c. Set the FREQUENCY dial and RANGE switch for desired output frequency.

d. Set ATTENUATION outer control to 0 dB, then set inner control (amplitude) for desired output voltage.

e. Set ATTENUATION outer control, if desired, to reduce output level in 10 dB steps.

NOTE

When the attenuator is in the 0 dB position the amplifier output is delivered from less than 600 ohms at frequencies below 5000 Hz, and it will produce its rated output (3 watts) across a load of 600 ohms. When the attenuator is positioned for 20 dB or more attenuation, the internal impedance is 600 ohms.

3-8. LOW LEVEL APPLICATIONS.

3-9. To avoid excessive noise and hum at low output levels (-40 dBm or less), it it good practice to attenuate the oscillator output -30 or -40 dB and use the amplitude control as an output vernier to obtain desired level.

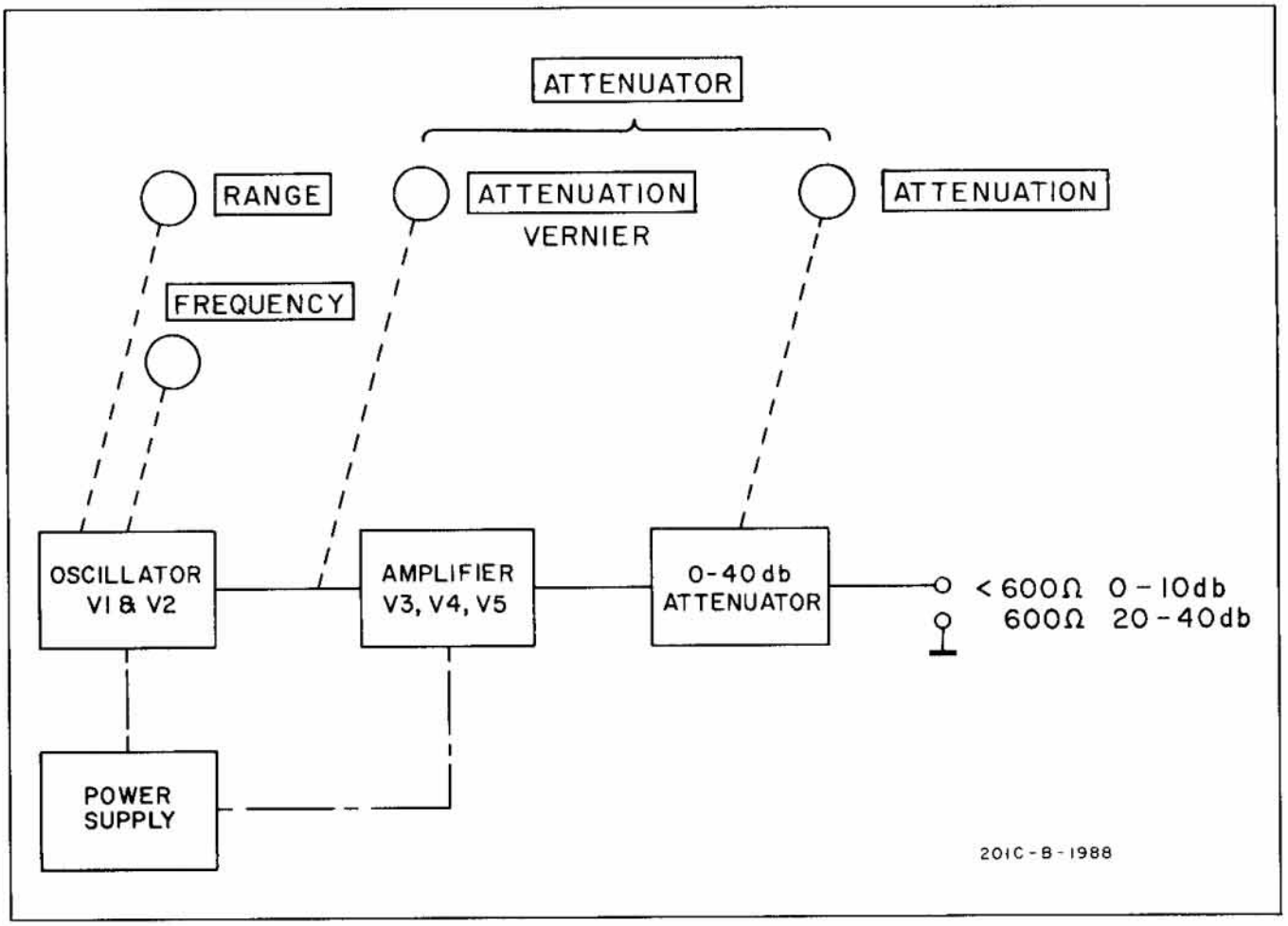


Figure 4-1. Block Diagram of Model 201C

SECTION IV
THEORY OF OPERATION

4-1. GENERAL.

4-2. The Model 201C consists of an oscillator section, an amplifier section, an output attenuator and a power supply as shown in the block diagram, Figure 4-1.

4-3. OSCILLATOR SECTION.

4-4. The oscillator section consists of V1 and V2 as a resistance coupled amplifier containing two feedback loops. The positive feedback loop sets up oscillation while the negative feedback loop reduces distortion and maintains a constant amplitude of oscillation. The positive feedback network contains fixed resistances (established by the RANGE switch) and a variable capacitance. A simplified schematic diagram is shown in Figure 4-2. The network is designed so that R1, C1A and B = R8, C1C and D.

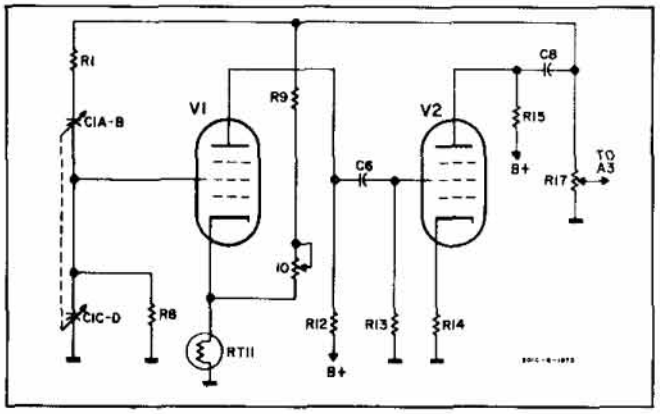


Figure 4-2. Simplified Schematic Diagram of Oscillator Section

4-5. The oscillator output is coupled to the input stage through C8, and the input voltage is derived from this signal. Oscillation will occur when there is zero phase shift between the voltage applied to the network and the voltage applied to the grid of V1. The zero phase shift point is also the point of minimum loss through the network as shown in Figure 4-3. The frequency of oscillation (relative frequency in Figure 4-3) is given by the expression:

$$Fr = \frac{1}{2\pi\sqrt{(R1 \cdot C1A,B)(R8 \cdot C1C,D)}}$$

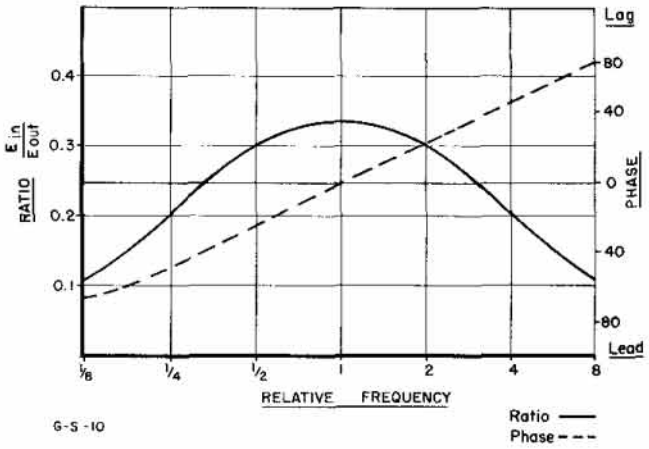


Figure 4-3. Oscillator Network Characteristics

4-6. The cathode by-pass capacitors in the oscillator section C5, C7 correct phase shift at higher frequencies.

4-7. The negative feedback network minimizes change of output amplitude with change in frequency. The incandescent lamp, used as a cathode bias resistor for V1, is part of the negative feedback voltage divider. It has a temperature resistance characteristic such that its resistance increases in direct proportion to the voltage applied to it. Thus, changes in its resistance will change the amount of negative feedback in the oscillator output. The thermal inertia of the lamp is great enough to be unaffected by sine wave voltages at the lowest frequencies involved.

4-8. AMPLIFIER SECTION.

4-9. The amplifier section of the instrument consists of a voltage amplifier V3A direct coupled to a phase inverter V3B, and a push-pull output stage V4 and V5. The output transformer contains a tertiary winding for overall negative feedback around the amplifier. As a result of negative feedback in excess of 30 dB, very little distortion is introduced by the amplifier section of the instrument.

Table 5-1. Recommended Test Equipment

Instrument Type	Required Characteristics	Model
Multi-Function Meter	DC Voltage Range: 1 to 310 volts Ohmmeter Range: 1 ohm to 500 megohms Accuracy: ±3% AC Voltage Range: 1 mV to 100 volts	-hp- Model 427A
Distortion Analyzer	Distortion Measurement Range: 20 Hz to 20 kHz Frequency Calibration Accuracy: ±2% Elimination Characteristics: Fundamental frequency reduced by more than 60 dB Sensitivity: Ability to measure distortion levels of 1% full scale	-hp- Model 331A
Electronic Counter	Frequency Range: 20 Hz to 20 kHz	-hp- Model 5223L

Table 5-2. Tube Replacement List

TUBE	TYPE	FUNCTION	CHECK REQUIRED
V1 V2	6AU6 6AQ5	Oscillator Oscillator	Table 5-5, step 2
V3	6SN7GT	Voltage Amp. phase inverter	Table 5-5, step 3
V4 V5	6V6GT 6V6GT	Output Tube Output Tube	Table 5-5, step 3
V6	5AR4	Rectifier	Table 5-5, step 1

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for the Model 201C Audio Oscillator. The section includes recommended test equipment, a tube replacement table, performance checks, adjustments, repair procedures and a troubleshooting table. The performance checks will verify proper instrument operation.

5-3. TEST EQUIPMENT.

5-4. Test equipment recommended for use in maintaining and checking performance of the Model 201C is listed in Table 5-1. Equipment having similar characteristics can be substituted for the equipment listed.

5-5. PERIODIC MAINTENANCE.

5-6. The tuning capacitor drive bearing should be lubricated once or twice a year depending upon the amount of use. One drop of light machine oil in each of the bearing holes is adequate. The holes are located in the bearing projections of the vertical casting behind the front panel.

5-7. The inside of the instrument should be cleaned occasionally to prevent accumulation of dust and dirt from shorting plates of the main tuning capacitor.

CAUTION

Clean tuning capacitor with extreme care. DO NOT apply any force to it which could bend the plates and destroy calibration. Compressed air under a pressure not to exceed 60 psi is recommended for cleaning.

5-8. PERFORMANCE CHECKS.

5-9. The Performance Checks are front panel procedures designed to compare the Model 201C with its published specifications. These checks may be incorporated in periodic maintenance, post repair, and incoming inspection. The Performance Checks should be conducted before any attempt is made to adjust or calibrate the instrument. A Performance Check Test Card is provided at the end of this section for recording the performance of the instrument. The card may be removed from the manual and used as a permanent record of the incoming inspection or of a routine Performance Check.

5-10. CALIBRATION ACCURACY CHECK.

a. Connect test setup as shown in Figure 5-1.

b. Check the period or frequency for each frequency setting shown in Table 5-3.

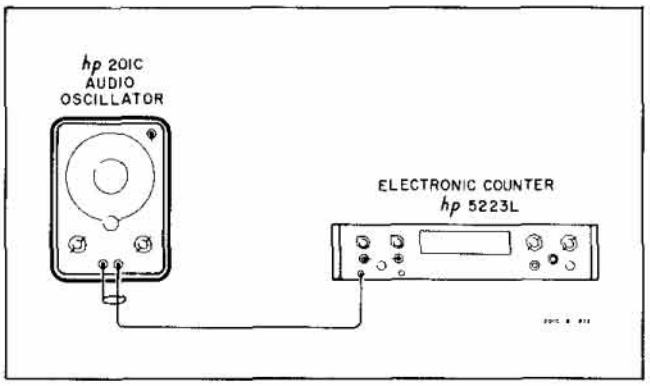


Figure 5-1. Calibration Accuracy Check

Table 5-3. Calibration Accuracy Check

Range	Dial Setting	Counter
X1	20	period: 49.5 to 50.5 ms
	50	period: 19.9 to 20.1 ms
	200	period: 4.95 to 5.05 ms
X10	20	period: 4.95 to 5.05 ms
	50	freq: 495 to 505 Hz
	200	freq: 1980 to 2020 Hz
X100	20	freq: 1980 to 2020 Hz
	50	freq: 4950 to 5050 Hz
	200	freq: 19800 to 20200 Hz

5-11. FREQUENCY RESPONSE CHECK.

a. Connect test setup as shown in Figure 5-2, including a 600 ohm load resistor across the output terminals of the Model 201C.

b. Set the Model 201C frequency to 1 kHz and Attenuation Switch to 0 dB.

c. Adjust the Model 201C amplitude vernier to obtain 0 dB reading on the voltmeter.

d. Set the Model 201C to each of the frequency settings in Table 5-4. At each setting the voltmeter should read 0 dB ±1 dB.

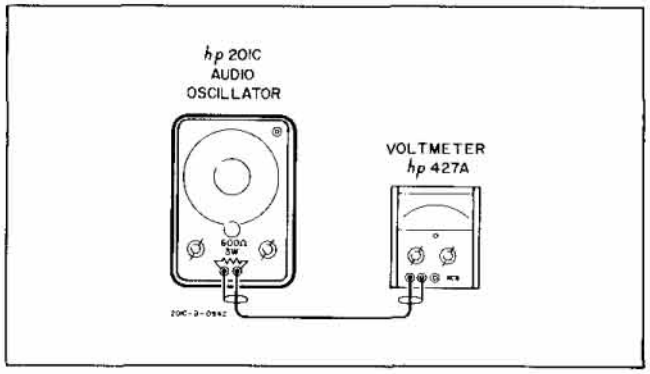


Figure 5-2. Frequency Response and Output Check

Table 5-4. Frequency Response Check

Range	Dial Setting	Tolerance
X10	20	-1 dB to +1 dB
	200	-1 dB to +1 dB
X1	20	-1 dB to +1 dB
	200	-1 dB to +1 dB
X100	20	-1 dB to +1 dB
	200	-1 dB to +1 dB

5-12. OUTPUT CHECK.

a. Connect test setup as shown in Figure 5-2, using a 600 ohm 3 watt load resistor.

b. Set the Model 201C Attenuation switch to 0 dB.

c. Increase attenuation vernier in CW direction until the voltmeter reads 42.5 volts. This is an output of 3 watts.

5-13. DISTORTION CHECK.

5-14. One-Watt Output.

a. Connect test setup as shown in Figure 5-3, including a 600-ohm load resistor across the output terminals of Model 201C.

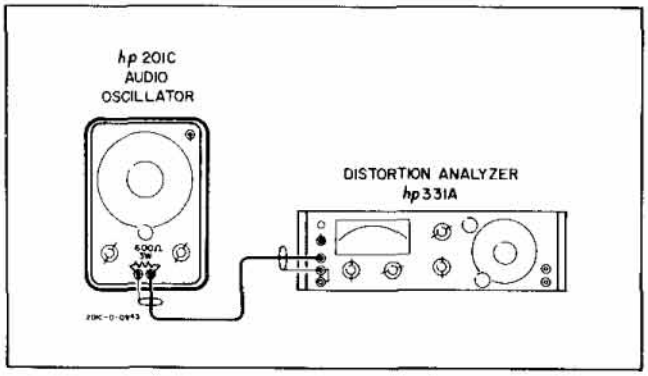


Figure 5-3. Distortion Check

b. Set Model 331A controls as follows:

INPUT . . . . . AF
FREQUENCY RANGE X1
FREQUENCY dial 50
FUNCTION . . . . . VOLTMETER
METER RANGE . . . . . 30 RMS VOLTS

c. On Model 201C set RANGE to X1 and frequency dial to 50 (50 Hz).

d. Adjust output voltage level of Model 201C, with vernier, to obtain 24.5 volts on Model 331A.

e. On Model 331A set FUNCTION to SET LEVEL, METER RANGE to 100%, and adjust INPUT SENSITIVITY for 100% (full scale is 100%).

f. Set FUNCTION to DISTORTION and tune Model 331A for null.

g. Set METER RANGE to 1% and retune for null. Reading should be less than 1/2% (full scale is 1%).

h. Repeat steps a through g, except set Model 201C RANGE to X100 and frequency dial to 200 (20 kHz) and Model 331A FREQUENCY RANGE to X1K and FREQUENCY dial to 20.

5-15. Three-Watt Output.

a. Connect test setup as shown in Figure 5-3, including a 600 ohm 3 watt load resistor across the output terminals of Model 201C.

b. Set Model 331A controls as follows:

INPUT . . . . . AF
FREQUENCY RANGE X1
FREQUENCY dial 20
FUNCTION . . . . . METER
METER RANGE . . . . . 100 RMS VOLTS

c. On Model 201C set RANGE to X1 and frequency dial to 20 (20 Hz).

d. Adjust output voltage level of Model 201C, with vernier, to obtain 42.5 volts on Model 331A.

e. On Model 331A set FUNCTION to SET LEVEL, METER RANGE to 100%, and adjust INPUT SENSITIVITY for 100% (full scale is 100%).

f. Set FUNCTION to DISTORTION and tune Model 331A for null.

g. Set METER RANGE to 1% and retune for null. Reading should be less than 1% (full scale is 1%).

h. Repeat steps a through g, except set Model 201C RANGE to X100 and frequency dial to 200

(20 kHz) and Model 331A FREQUENCY RANGE to X1K and FREQUENCY dial to 20.

NOTE

If the Model 201C is slightly out of specification, refer to "Adjustments" Paragraph 5-16 and "Factory Selected Components" Table 5-6. If a malfunction exists refer to "Troubleshooting" Paragraph 5-24.

5-16. ADJUSTMENTS.

5-17. POWER SUPPLY.

5-18. Proper operation of the power supply is vital to proper operation of the instrument. Excessive ripple in the output or a low output voltage can cause the instrument to have excessive distortion or otherwise operate out of specification. To check the power supply, measure the power supply ripple and check the B+ voltage as described in Table 5-5 (1). For cabinet removal refer to Paragraph 5-33.

5-19. OUTPUT VOLTAGE.

a. Connect Model 201C as shown in Figure 5-2 and proceed as follows:

b. Rotate RANGE switch to X10 position.

c. Rotate frequency dial to 20.

d. Rotate amplitude control to 100 (fully clockwise).

e. Set ATTENUATION switch to 0 dB position.

f. Adjust R10 for 45 volt indication on the voltmeter.

5-20. DISTORTION ADJUSTMENT.

a. Connect the 201C output to the input of the 331A Distortion Analyzer as in Figure 5-3.

b. Set the 201C frequency dial to 50 and the Range to X1.

c. Set the attenuation controls for a 42.5 volt output into a 600 ohm load.

d. Adjust R48 for minimum distortion as indicated by the 331A.

5-21. FREQUENCY CALIBRATION.

a. Turn on the oscillator and allow 30 minutes for it to warm up. Put 600 ohm resistive load on oscillator for all adjustments.

b. Set the RANGE switch to X10 and the dial to 20. Connect the instrument to the Frequency Counter.

c. If the output from the Model 201C is not 200 Hz adjust R7A so that the output is exactly 200 Hz when the dial rests on 20 (X10 range).

NOTE

It is necessary to remove the instrument from the cabinet for each adjustment, and then replace it for check after each adjustment. The instrument oscillates at a different frequency when removed from the cabinet. Use non-metallic (bakelite, etc.) aligning tools to adjust trimmer capacitors.

d. Set the Model 201C output to any convenient level for reference. Change the dial setting to 200 and note the output. The level should remain at the established reference, and frequency should be within ±1/2 percent of 2000 Hz. If this is not the case, adjust C2 and C4 alternately to obtain 2000 Hz at the established reference level.

e. Check dial tracking across the X10 range. In nearly all cases the dial tracking should be satisfactory. If, however, the dial is out of calibration in the same direction across the band, the dial may be adjusted slightly relative to the tuning unit as follows:

1. Remove center knob on frequency dial.

2. Loosen four screws which secure dial plate to drive shaft.

3. Reset dial by desired amount.

4. Tighten four securing screws. Replace center knob.

5. Repeat steps b through d of Paragraph 5-21.

f. If the dial tracking cannot be brought into specifications in this manner, or by compromising the calibration at the band extremes slightly (within specifications) to accommodate a larger error in the middle of the band, then a retracking of the dial and the main tuning capacitor is indicated. Retracking the dial involves bending the split rotor plates on the main tuning capacitor C1. Assuming dial retracking is unnecessary, proceed with steps g and h.

g. Place RANGE switch in the X100 position, and turn the frequency dial to 20. Adjust R6A so that the instrument oscillates at 2 kHz.

h. Place RANGE switch in the X1 position, and set the frequency dial to 20. Adjust R8A so that instrument oscillates at 20 Hz.

5-22. DIAL RETRACKING.

5-23. Dial tracking is performed on the X10 range.

a. Check frequencies at 200, 150, 100, 70, 50, 30, and 20 on the dial.

b. For each point outside specifications, bend split rotor plates (these plates are the outside plates of each section of C1) as described below to bring point on dial into calibration.

NOTE

Outside rotor plates of each section are divided into segments. The segment associated with specific dial points are those which engage the stator when the desired dial point is under the index. To raise the frequency spread the plates. To lower frequency squeeze plates.

c. Start bending at highest frequency out of calibration, and work toward the lowest frequency. Bend the plates of the front two sections by the same amount as the rear two sections. It should not be necessary to bend plates near the high end of the dial.

d. If the above procedures do not result in correct calibration, start over by adjusting C2 and C4. Then work toward the low end by setting the dial to the next numbered point and bending one of the outer rotor plates in each section of C1 at the point of mesh. Continue this procedure to the low end of the dial to obtain approximately correct frequencies. Repeat the bending procedure from the high end, this time making fine adjustments of frequency with the other outer rotor plates. In this way, bending of any one plate is minimized.

e. If bending process moves the dial out of calibration at "20", restore calibration at this point by bending the plates rather than by an adjustment of R7A.

NOTE

If the X10 range is within specifications, and the high end of the X1 or X100 range is out of specifications, refer to "Factory Selected Components", Table 5-6.

5-24. TROUBLESHOOTING.

5-25. TROUBLE LOCALIZATION.

5-26. If the instrument fails to operate, check the power source, power cord, and fuse before attempting more complicated troubleshooting. If the instrument operates, but not satisfactorily, check the test setup for correct voltages, connections, terminations, etc.

5-27. The conservative design of the Model 201C indicates that most normal aging effects will be remedied by tube replacement and subsequent adjustments. Electrical troubleshooting should always be preceded by a visual inspection. A cold tube found simply by touch may save considerable time and effort in restoring the instrument to operation. Look for signs of damage and overheated or burned-out components associated with certain types of tube failure; be alert for looseness of parts which, if not trouble sources themselves, suggest areas of future trouble. The Troubleshooting Chart, Table 5-5, lists checks to be performed starting with the power supply and proceeding through the instrument in a manner which isolates circuit failures and also includes possible causes and remedies. Isolation of a circuit failure is often possible by simply operating the front panel controls and observing their effect.

5-28. TROUBLESHOOTING CHART.

5-29. For simplification in the following chart, tubes usually have been referenced, but remember that components associated with reference tubes are also failure possibilities. Perform the steps in the chart in the order given since the chart assumes that the section ahead of the one under investigation is operating satisfactorily. For all testing of the Model 201C the use of a variable transformer to adjust the line voltage to ±10% of the normal line voltage is recommended. An instrument in good condition should operate over this range. An instrument with marginal operation (from weak tubes, etc.) can be quickly identified at low line voltages, and such weaknesses become easier to trace.

5-30. EXCESSIVE DISTORTION.

5-31. In general, distortion in the Model 201C can come from the following:

a. Leaky coupling capacitors, C6, C8, C9, C10, C11. There should be no dc voltage on grids following these capacitors.

b. Defective electrolytic filter and decoupling capacitors. Make ripple measurements as described in Table 5-5.

c. Defective tubes. When a tube is replaced in the instrument, the distortion measurement should be rechecked.

d. Low B+. Check the supply voltages against those shown in the Voltage and Resistance diagram with a line voltage of 115 volts.

5-32. REPAIR.

Table 5-5. Troubleshooting Chart

CHECK OR SYMPTOM	POSSIBLE CAUSE	REMEDY
1. POWER SUPPLY		
Measure +310 VDC (at 115 V line) between pin 8, V6 and chassis.		
Voltage low	Defective V6	Replace
Measure power supply ripple at pin 4 of V4 or V5.		
Ripple in excess of .25 vac.	Defective filter capacitor C12B or C	Replace
	Defective V6	Replace
Measure ripple at junction R28 and C12A.		
Ripple in excess of 0.01 vac.	Defective C12A	Replace
2. OSCILLATOR		
Measure oscillator hum between negative terminal of C8 and chassis. Remove lamp RT11 to eliminate oscillator signal.		
Hum in excess of 0.02 vac.	Defective V1 or V2	Replace.
Replace lamp and measure oscillator voltage between negative terminal of C8 and chassis (see Figure 5-5).		
Oscillator voltage not within range indicated on schematic.	Defective lamp RT11.	Replace lamp (See Paragraph 5-37).
	R10 out of adjustment. Defective V1 or V2.	Adjust R10 for proper oscillator voltage or replace V1 or V2.
	Dirty contacts on RANGE switch	Check and clean RANGE switch. Replace assembly when resistors are open or damaged. See Paragraph 5-39.
	Shorted C1, C2, C3, or C4.	Replace defective trimmers (C2, C3, or C4). Foreign material may short C1.
Excessively high OSC voltage.	Defective lamp RT11. (Notch will appear in oscillator output waveform viewed on oscilloscope.)	Replace lamp (See Paragraph 5-37).
Measure distortion between negative terminal of C8 and chassis.		
If it exceeds .5% at 1 watt and 1000 Hz.	Defective V1 or V2 Defective lamp, RT11	Replace (See Paragraph 5-35). Replace lamp.

Table 5-5. Troubleshooting Chart (Cont'd)

CHECK OR SYMPTOM	POSSIBLE CAUSE	REMEDY
3. AMPLIFIER		
Load instrument with 600 ohms. Measure low frequency distortion at output terminals.		
Excessive 2nd Harmonic distortion.	Defective V4 or V5	Replace
Load instrument with 600 ohms. Measure signal voltage on V3A grid (pin 5) for approximately 13 V rms when instrument delivers 1 watt. Signal voltage on grids (pin 5) of V4 and V5 should be approximately 5 V rms.		
Weak signals driving V4 and V5.	Defective V3	Replace
Amplitudes of signals driving V4 and V5 not equal.	Defective R21 or R22	Investigate and replace
Rotation of amplitude control causes erratic amplitude variation in output.		
Measure dc voltage for approximately 0.2 volts. Voltage high.	Defective C9	Replace (See Paragraph 5-31).
Voltage above satisfactory. Control still produces unstable output variation.	Defective R17	Replace

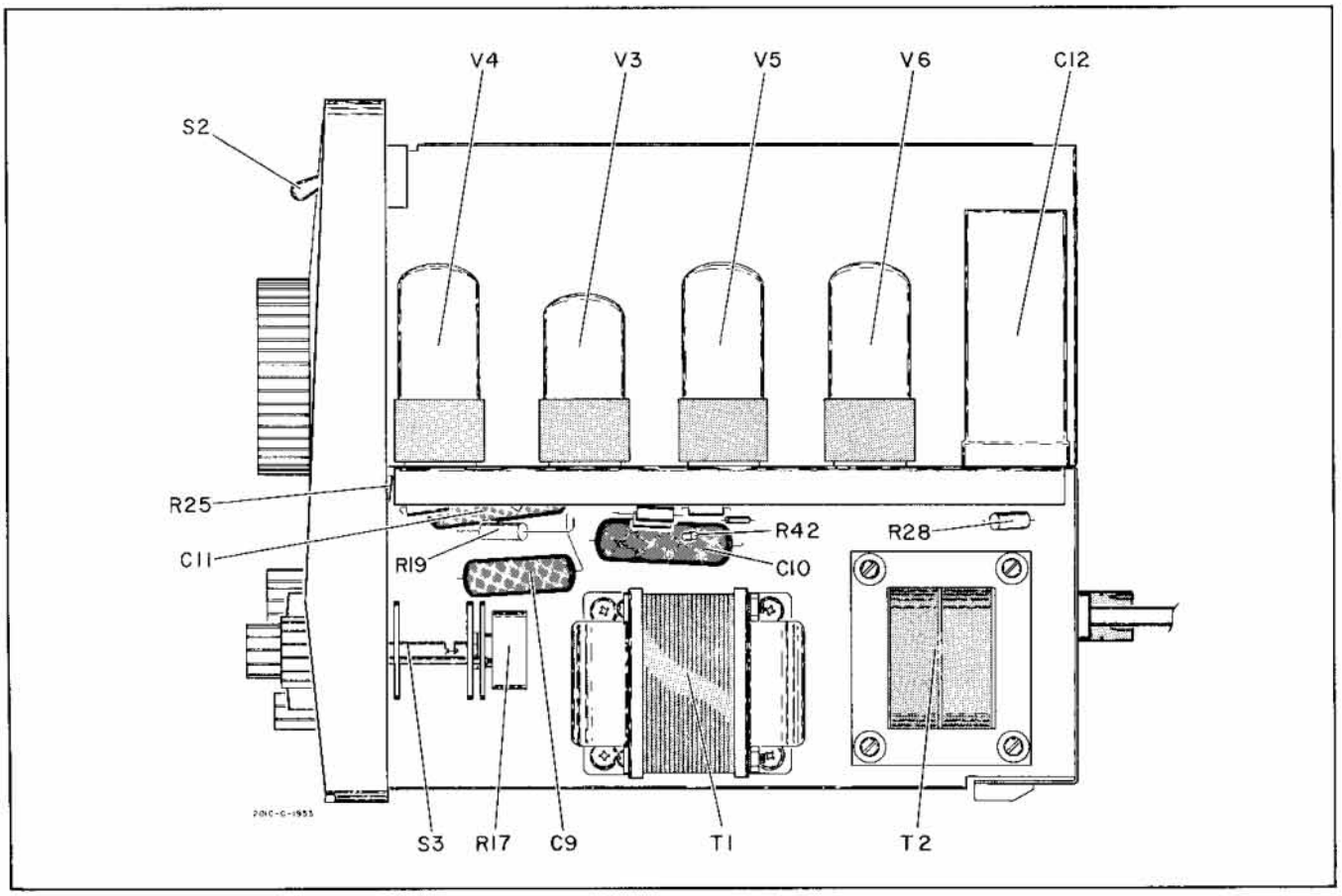


Figure 5-4. Left Side View

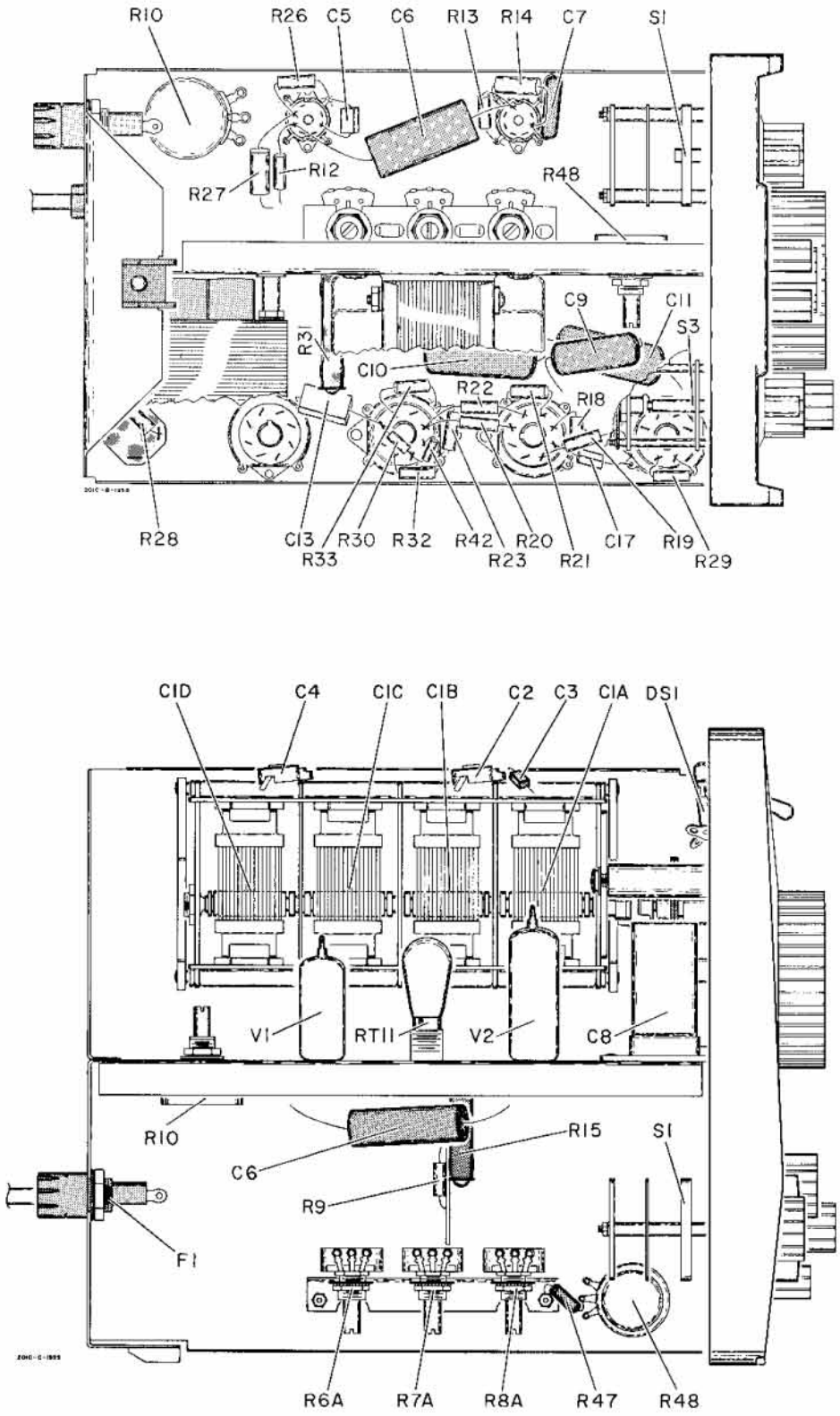


Figure 5-5. Bottom and Right Side Views

5-33. CABINET REMOVAL.

5-34. To remove instrument from the cabinet, unscrew the two machine screws on the rear of cabinet and pull front panel forward. The bezel remains attached to front panel.

5-35. TUBE REPLACEMENT.

5-36. Tubes used in the Model 201C are listed in the Tube Replacement List (Table 5-2). A tube may be replaced with any tube of its type having standard characteristics, but distortion measurements should be made after replacing any tube, with the exception of the rectifier tube, to insure that the instrument still meets the specifications set forth in the front of this manual.

5-37. REPLACEMENT OF LAMP, RT11.

5-38. The lamp operates well below its rating and should have a long life, unless it is damaged by severe mechanical vibration. A damaged lamp may be detected by the presence of a notch in the output waveform, and by the presence of excessive oscillator voltage. If the lamp opens, the circuit will not oscillate. When the lamp is replaced, check the oscillator voltage between the negative terminal of C8 and the chassis. If the voltage does not fall within the limits specified on the schematic, adjust R10 to obtain proper oscillator voltage.

5-39. REPLACING RANGE SWITCH.

a. Remove instrument case (see Paragraph 5-33).

b. Remove defective RANGE switch. Note routing of leads.

c. Install replacement switch with black wire toward the center shield of the chassis and the wiper lugs on the ceramic wafer horizontal.

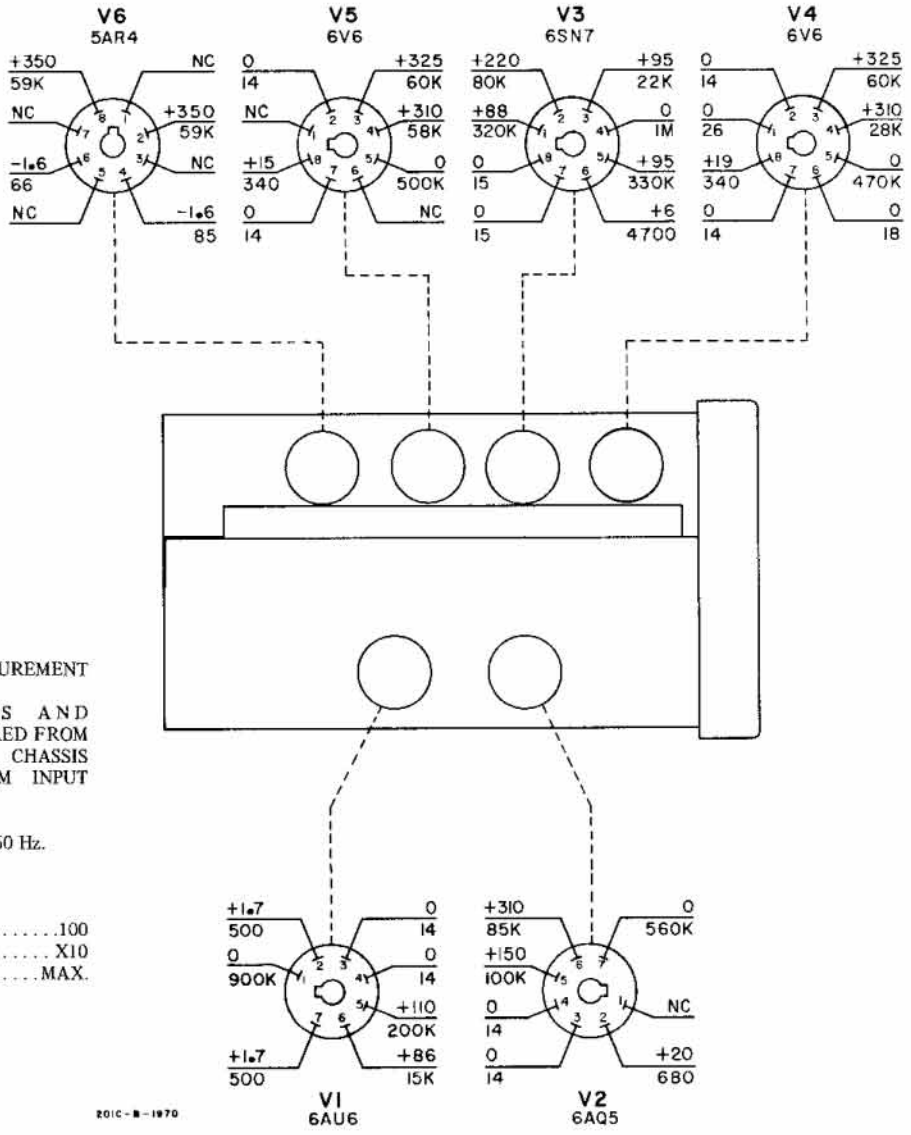
d. Carry out frequency calibration procedure as described in Paragraph 5-21.

5-40. ADJUSTMENT OF FACTORY SELECTED COMPONENTS.

5-41. Certain components within the Model 201C are individually selected in order to compensate for slightly varying circuit parameters. These components are denoted by an asterisk (*) on the schematic, and the typical value is shown. Table 5-6 describes the function of the factory selected components and gives instructions for their selection. Normally, these components do not need to be changed unless another associated component is changed.

Table 5-6. Factory Selected Components

COMPONENT	FUNCTION AND SELECTION	MIN.	AVERAGE	MAX.
C5*	Compensates for High Frequency response Decrease C to increase amplitude (X100 range).	27 pF	56 pF	68 pF
C13* and R30*	Minimizes distortion at 20 kHz Change size of R30 first. C13 has very little effect. Value of R30 is function of oscillator tubes.	10 kohm	560 pF 12 kohm	16 kohm
C14*	Adjusts frequency at high end of X10 range.	0	0	1.5 pF
C15*	Adjusts frequency at high end of X1 range.	0	1 pF	50 pF
C17*	Decreases distortion caused by oscillations in the output amplifier.		47 pF	
R9*	Provides proper range for R10 Output Voltage Adjustment. Increase R9 to increase amplitude.	1800 ohms	2200 ohms	2600 ohms
R14*	Adjusts bias level of V2.		680 ohms	
R20*	Changes loop gain of amplifier.		270 kohms	



NOTES

1. CONDITIONS OF MEASUREMENT

   ALL VOLTAGES AND RESISTANCES MEASURED FROM POINTS SHOWN TO CHASSIS WITH 122 MEGOHM INPUT IMPEDANCE VTVM.

   LINE VOLTAGE: 115V/60 Hz.

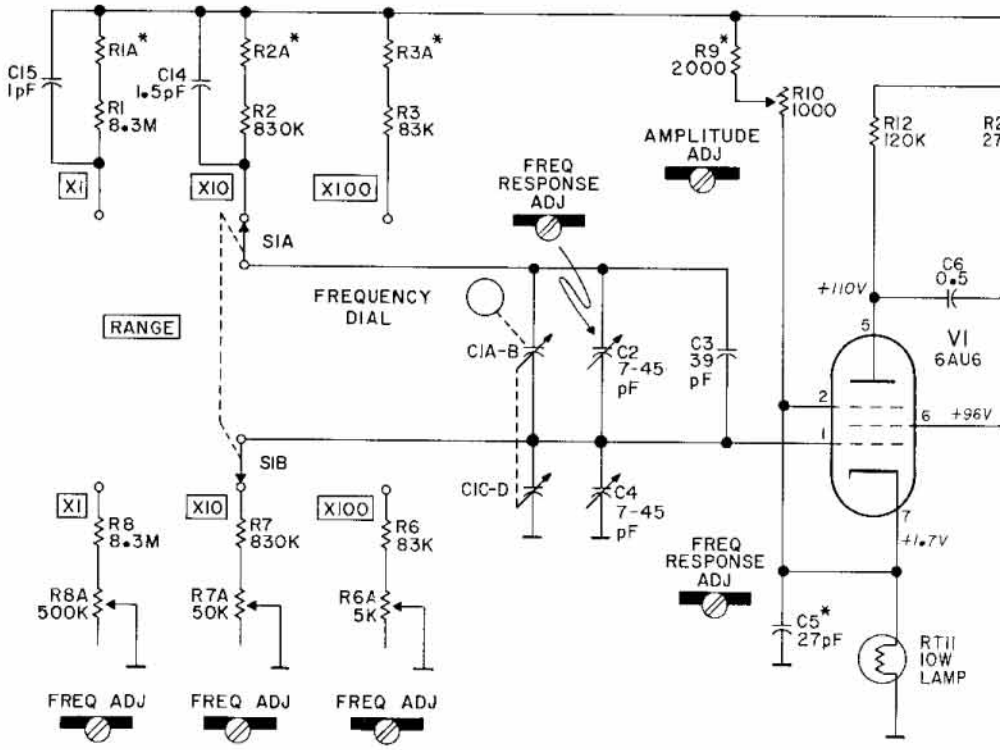
2. CONTROL SETTINGS

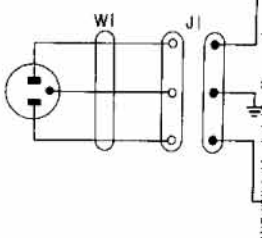
   FREQ. DIAL 100
   RANGE X10
   AMPLITUDE .....MAX.

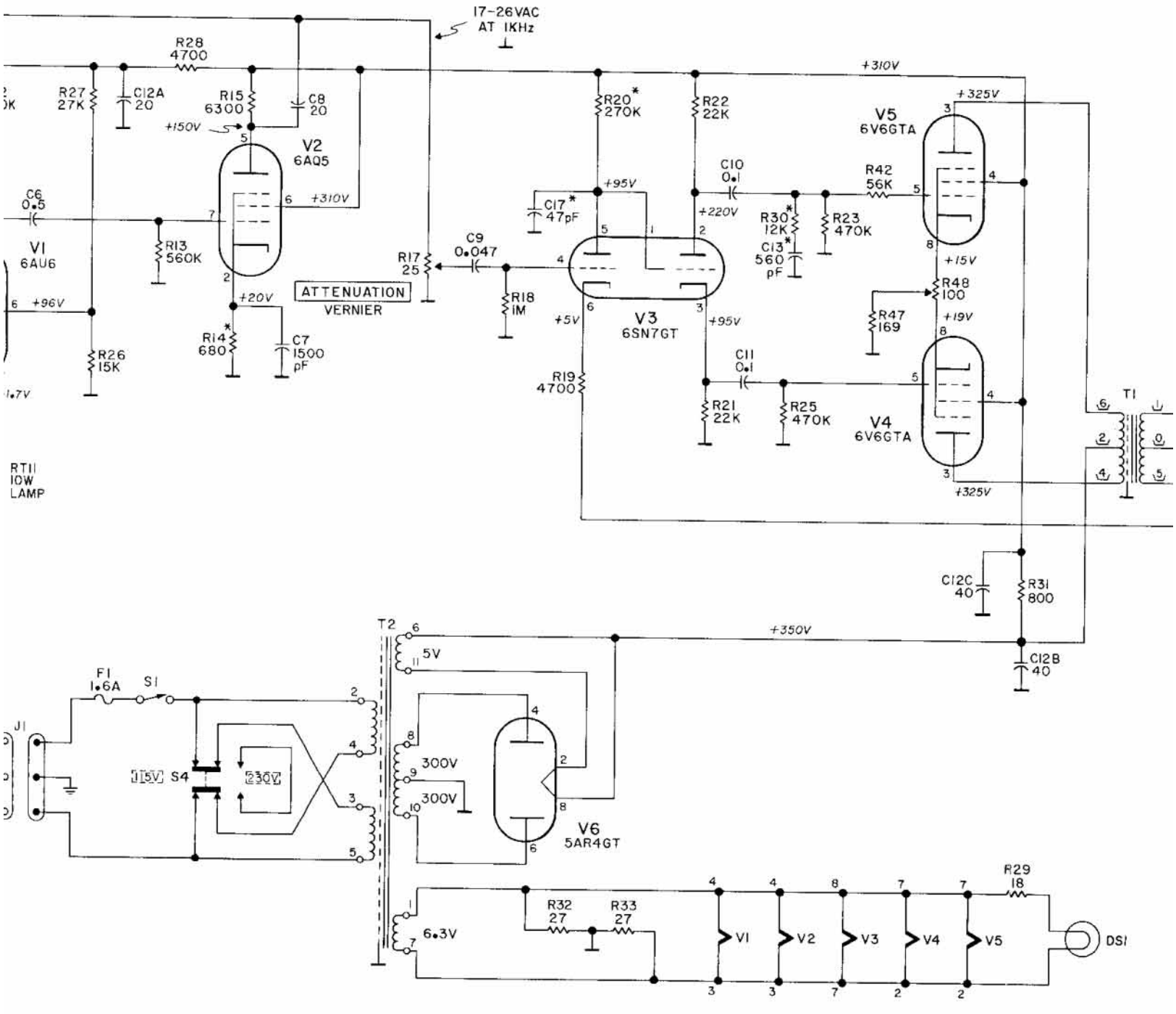
Figure 5-6. Tube Location, Voltage and Resistance

NOTES

1. VOLTAGES MEASURED BETWEEN INDICATED POINTS AND CHASSIS WITH VOLTMETER OF 122 MEGOHM INPUT RESISTANCE.
2. CAPACITY VALUES IN μF, RESISTANCE IN OHMS UNLESS OTHERWISE NOTED.
3. * VALUE SELECTED DURING MANUFACTURE.
4. PANEL CONTROL
5. PANEL MARKING
6. SCREWDRIVER ADJ.
7. ⊥ CHASSIS GROUND.
8. ⏚ EARTH GROUND.






17-26VAC AT 1KHz
R28 4700
R27 27K
C12A 20
R15 6300
C8 20
+150V
V2 6AQ5
C6 0.5
V1 6AU6
R13 560K
+310V
+20V
R14* 680
C7 1500 pF
R26 15K
+96V
ATTENUATION VERNIER
R17 25
C9 0.047
R18 1M
R20* 270K
R22 22K
+95V
C17* 47pF
+220V
C10 0.1
R30* 12K
C13* 560 pF
R23 470K
R42 56K
V5 6V6GTA
+325V
+15V
R48 100
+19V
R47 169
V3 6SN7GT
+5V
+95V
C11 0.1
R19 4700
R21 22K
R25 470K
V4 6V6GTA
T1
RTI1 10W LAMP
+325V
C12C 40
R31 800
+350V
C12B 40
T2
F1 1.6A
S1
J1
115V S4 230V
5V
300V
300V
V6 5AR4GT
6.3V
R32 27
R33 27
V1
V2
V3
V4
V5
R29 18
DS1

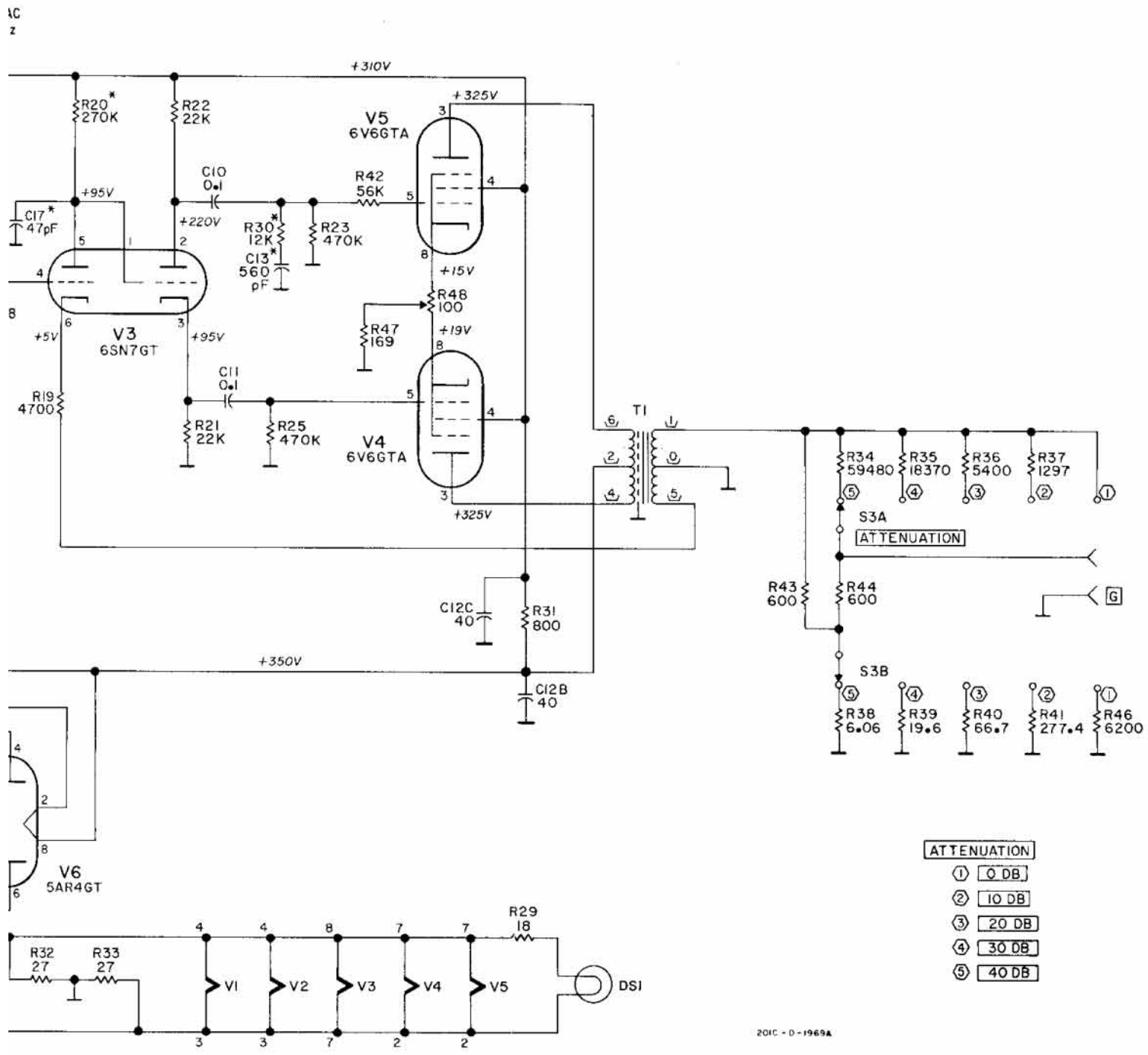


Figure 5-7. Schematic Diagram
Page 5-9/5-10

MANUAL BACKDATING CHANGES

MODEL 201C

AUDIO OSCILLATOR

Manual Serial Prefixed: 351-
-hp- Part No. 201C-906

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Number	Make Manual Changes
557 and below	1 through 9, 11, 12, 13
558 through 857	2 through 9, 11, 12, 13
858 through 1257	3 through 9, 11, 12, 13
1258 through 1358	4 through 9, 11, 12, 13
006- and 133-	5 through 9, 11, 13, 14
236-	6 through 9, 11, 12, 13
308-	7 through 9, 11, 12, 13

Instrument Serial Number	Make Manual Changes
311-	8 through 13
331-	9 through 13
351-06108 and below	10, 11, 12, 13
351-06158 to -06108	11, 12, 13
351-06357 to -063158	12, 13
All	Attenuator switches

CHANGE NO. 1

Table of Replaceable Parts:
Coupler, flexible: Change to -hp- Part No. 5060-0210.
C12A is single capacitor, 10 uF; -hp- Part No. 0180-0002.
Change C12B to C12A, B.

CHANGE NO. 2

Table of Replaceable Parts and Figure 5-8, Schematic:
Delete R42, 45.
Change T1 to -hp- Part No. 9120-0037.
If T1 is replaced by current Part No., add R42 and R45.

CHANGE NO. 3

Frequency drive gears are changed; separate parts are available for replacement.
For entire gear assy replacement, use current gear assy, -hp- Part No. 200AB-36B Gear (32 pitch); 200AB-36C Gear (32 pitch); 2AC-100Y shaft with gear (32 pitch).

Table of Replaceable Parts:
Add C16*: 560 pF (factory adjusted), -hp- Part No. 0140-0028 (average value).
Add R16*: 6800 ohms (factory adjusted), -hp- Part No. 0690-6821 (average value).
Parallel combination R16 and C16 is connected in series with signal lead to (top) AMPLITUDE control R17.
Delete R46.

CHANGE NO. 4

Delete C17* (This capacitor may be added to improve distortion.)

CHANGE NO. 5

Table of Replaceable Parts, Miscellaneous:
Add the following:

Disc, vernier	5020-0236
Disc, vernier drive	5040-0211
Spring, compression	1460-0019

Delete the following:
Disc assy, vernier drive; -hp- Part No. 5040-0607; Mfr. 28480; TQ 1.
Spring thrust; -hp- Part No. 5000-0637; Mfr. 28480; TQ 1.
(It is advisable to replace with current vernier drive assy.)

CHANGE NO. 6 Table of Replaceable Parts:
S3: Attenuator switch assy, w/pot; change to 201C-19A;
pot only – -hp- Part No. 2100-0115;
switch w/pot – -hp- Part No. 3100-0124.

CHANGE NO. 7 Table of Replaceable Parts: (see Figure 1)
Add R46: 390 kohms, -hp- Part No. 0687-3941.
R9: Change to 2.4 kohms, -hp- Part No. 0689-2425.
R12: Change to 82 kohms, -hp- Part No. 0690-8231.
R14: Change to 1 kohm, -hp- Part No. 0693-1021.
R15: Change to 7.5 kohms, -hp- Part No. 0816-0007.
V1: Change to 6SJ7, -hp- Part No. 1923-0037.
V2: Change to 6K6, -hp- Part No. 1923-0033.

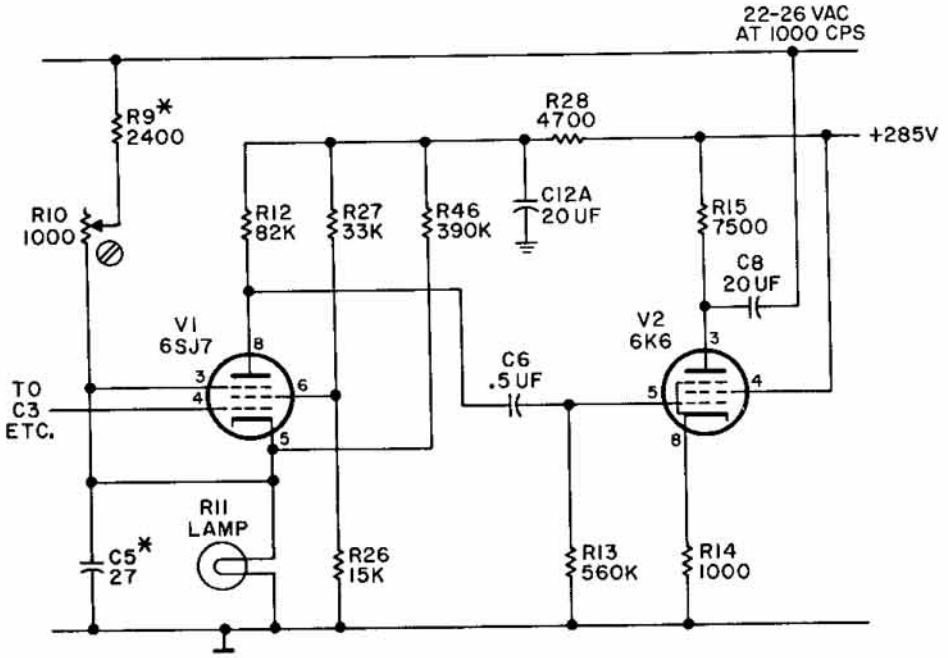


Figure 1

CHANGE NO. 8 Table of Replaceable Parts:
C12: Change to 4 section, 20 uF/sect, -hp- Part No. 0180-0025.
C12B: Change to 20 uF.
R27: Change to 33 kohms, -hp- Part No. 0693-3331.

NOTE

Stock No's. in current manual may be used to improve hum and distortion.

CHANGE NO. 9 Table of Replaceable Parts:
Rotary, switch, with pot: change to -hp- Part No. 3100-0371; pot only, -hp- Part No. 2100-0385.
Knob: change to -hp- Part No. 0370-0024.

CHANGE NO. 10 For Serials Prefixed 311-, 331- and 351-06108 and below only.
Table of Replaceable Parts and Figure 5-8 Schematic:
Delete R46

CHANGE NO. 11 Table of Replaceable Parts and Figure 5-8 Schematic
Delete: C13 and R30.

CHANGE NO. 12 Table of Replaceable Parts and Figure 5-8, Schematic:
Delete: R47, 169 ohm resistor -hp- Part No. 0811-0041 and R48 potentiometer 100 ohms -hp- Part No. 2100-0730.
Add: R24 Resistor, fxd comp 470 ohms ±10% 2 W -hp- Part No. 0693-4711 and R45 Resistor fxd comp 1 kohm ±10% 2 W -hp- Part No. 0693-1021. Change schematic diagram as in Figure 2.

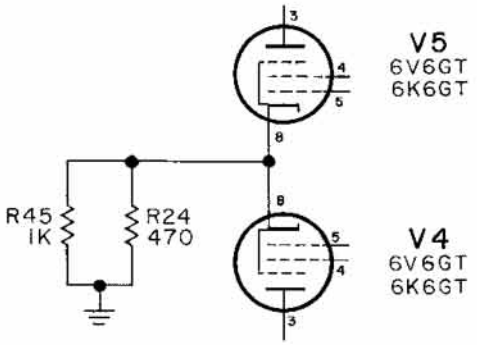


Figure 2

ATTENUATOR S3

Instrument Serial No.	Switch with pot	Pot alone
0 to 236-03207	3100-0124	2100-0115
308-03208 to 331-03632	3100-0371	2100-0385
351-03633 and above	3100-0788	2100-0839

NOTE

The above switches and pots must be used together as designated although the current attenuator assembly may be used on any serial numbered instrument.

CHANGE NO. 13 Figure 5-7:
Change primary power input to T2 as shown below:

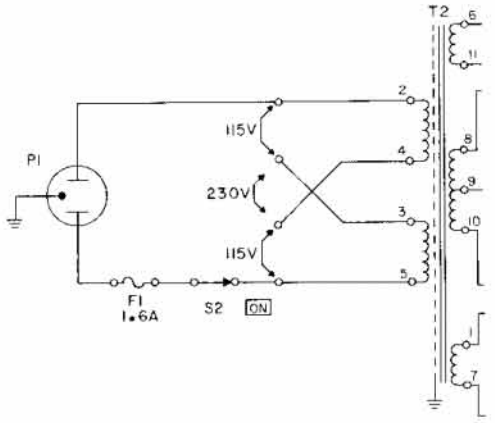


Table 6-1:
Change -hp- part no. W1 to 8120-0050
Change -hp- part no. of Shield: bottom (in miscellaneous) to 200AB-6B.
Change -hp- part no. of Bracket: pot (in miscellaneous) to 618B-12B.
Delete J1 and S4.

CHANGE NO. 14 Table 6-1:
Change the -hp- part no. of MP1 to 1500-0002.
Change the -hp- part no. of MP2 to 5040-0212.